Research Article

Effect of Age on the Score of the Persian Version of the University of Cincinnati Auditory Processing Inventory: A Pilot Study

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Highlights

- Auditory processing is declined with the increase of age
- Separate norms of the P-UCAPI are needed for different age groups

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ABSTRACT

Background and Aim: The Persian version of the University of Cincinnati Auditory Processing Inventory (P-UCAPI) is used to evaluate auditory processing disorders in Iranian people using six subscales, each focusing on different auditory skills. In this study, we aimed to compare the total score and the subscale scores of the P-UCAPI among three age groups to evaluate the impact of aging on auditory processing.

Methods: Participants in three age groups of 20, including 21–39 years (group A), 42–60 years (group B), and 61–80 years (group C) completed the P-UCAPI. One-way ANOVA and Welch's t-test was used to compare the mean scores of each subscale among the three groups.

Results: The mean scores of listening and concentrating ($p<0.001$), understanding speech ($p<0.001$), attention ($p=0.010$), and other ($p<0.001$) were significantly lower in group C compared to group A. The mean scores of listening and concentrating ($p=0.001$), understanding speech ($p<0.001$), and other ($p<0.001$) were significantly lower in group C compared to group B. The mean total score was not significantly different between groups A and B ($p=0.333$). However, the difference was significant between groups A and C ($p<0.001$) and between groups B and C ($p<0.001$).

Conclusion: The increase of age affects the auditory processing and generally reduces the auditory performance.

Keywords: Age; auditory processing disorders; inventory; Persian

Introduction

The peripheral auditory system receives auditory signals, translates them to neural signals, and sends them to upper auditory neural centers by the bottom-up mechanisms. Simultaneously, the central auditory system that uses the top-down mechanisms to modulate information received from the peripheral system plays a critical role in processing auditory information. These two auditory systems work together and help each other to achieve better speech and auditory perception [1]. Some people, despite having normal hearing, have difficulties listening, which may be due to Auditory Processing Disorder (APD). These problems become even more noticeable when listening to the speech in noisy environments or in places with suboptimal acoustics [2]. Therefore, it is difficult for people with APD to understand speech in noise [3, 4]. The APD is a deficit in the neural processing of auditory information in the central auditory system. The condition is not due to problems in higher-order language processing or cognition [5]. Several skills may be impaired in patients with APD, such as auditory discrimination, temporal processing, and binaural processing [6]. Speech comprehension may also be compromised due to impairment in some of these skills. Given the importance of affected skills in APD, numerous diagnostic tests have been developed so far. Since the diagnostic tests are complicated and require clinical equipment, a screening tool may be more desirable. The results of screening tools can identify individuals who may benefit from the diagnostic tests or those who may not be good candidates for testing.

The American Speech-Language-Hearing Association (ASHA) and the American Academy of Audiology (AAA) have stated that individuals with APD can be identified by screening and diagnostic tools. Due to the ease of use and being cost-effective, questionnaires have been developed to identify people with APD. However, most of the existing questionnaires have been designed for children, and some questionnaires do not have enough items to address the various types of APD. The University of Cincinnati Auditory Processing Inventory (UCAPI) is a questionnaire with 34 items designed to identify the several components of auditory processing in adolescents and adults [3]. It contains six subscales: listening and concentrating, understanding speech, following spoken instructions, attention, educational assistance, and other [3]. This questionnaire can be used by experts to determine whether a person has a possible APD and is a candidate for diagnostic testing. Keith et al. [3] developed normative data for UCAPI in young adults. They indicated that these normative data should be used with caution in individuals aged 30 and older. The Persian version of UCAPI (P-UCAPI) was validated by Bagheri et al. [7]. They administered the questionnaire to subjects aged 13–52 years. Since neural processing changes gradually with aging, it is important to consider the effect of age in developing normative data, especially when aging is associated with the risk of hearing loss. Since Bagheri et al. [7], did not include the elderly group in their study, this study aims to administer P-UCAPI to three age groups, including the elderly. Considering the narrow range of scores in the UCAPI, we hypothesized that different age groups, including the elderly, may obtain varying scores in P-UCAPI. Therefore, further research is needed to determine normative data for each age group separately.

Methods

The Persian-university of Cincinnati auditory processing inventory

The P-UCAPI has 34 items, 7 items survey the personal information, educational level, occupational status, and any hearing and developmental problems. The remaining 27 items measure six subscales, including listening and concentrating, understanding speech, following spoken instructions (each with 3 items), attention (with 6 items), educational assistance (with one item), and other (with 11 items, including two descriptive questions about auditory processing problems). Five questions in the “Other” subscale are for individuals with attention deficits, which were ignored by the participants in our study. Most items are rated on five-point scale while 3 items related to the attention subscale are answered by “yes” or “no”. The item for the educational assistance subscale has five options, each is answered by yes or no. The higher score in each category represents poorer performance. The total score is obtained by summing the scores of six subscales.Classification of P-UCAPI scores are shown in Table 1.

Table 1. Classification of the Persian-university of Cincinnati auditory processing inventory scores

	Total	Listening and comprehension	Understanding speech	Following directions	Attention	Education	Other
Typical normal response	56	15	6	8	6	5	15
Weak (+1SD)	>67	20	8	10	8	7	18
Abnormal (+2SD)	>79	25	12	12	10	9	23
Disordered (+3SD)	>91	30	14	14	12	11	28

Table 2. Demographic information of groups A, B and C

Group	Mean age±SD	Number of participants
A (21 to 39 years)	29.50±5.90	F: 10, M: 10
B (42 to 60 years)	49.75±6.40	F: 7, M: 13
C (61 to 80 years)	71.50±6.34	F: 12, M: 8

F; female, M; male

Participants

This study was conducted on 60 subjects in three age groups of 20 including 21–39 years (group A), 42–60 years (group B), and 61–80 years (group C). Mean age of the participants in each group are shown in Table 2. The participants were selected from the general population, including friends, colleagues, and family members of the authors, and also some university students. None of the participants had a history of psychologic, physiologic, or neurologic problems and traumatic brain injury. The participants were selected based on the inclusion criteria: being a Persian speaker, at least a primary school education (3rd grade), normal hearing thresholds average in both ears (>20 dB HL at 500, 1000 and 2000 Hz, and <55 dB HL at 2000, 4000 and 8000 Hz), no greater than 10 dB difference in hearing threshold between the two ears at each frequency, speech discrimination score of 84% or higher in each ear, no complaint of tinnitus handicap based on the tinnitus handicap inventory score [8]. The study objectives were explained to the participants and they signed a written informed consent form. Then, they completed the P-UCAPI. They were free to ask questions in case of any problem in understanding the questions.

Statistical analysis

Data analysis was performed in IBM SPSS Statistics v.17. The normality of data distribution was examined using Shapiro-Wilk test in addition to measuring kurtosis and skewness. Levene's test was used to examine the homogeneity of variance. One-way ANOVA was used to examine the difference in mean P-UCAPI scores between the study groups. The Turkey's post hoc test was used to pairwise comparison of the mean P-UCAPI scores. In cases of heterogeneity of variances, Welch's t-test and the Games-Howell post hoc test were used for pairwise comparison. The significance level was set at 0.05.

Results

Descriptive statistics of the total score and subscale scores of P-UCAPI are presented in Table 3. The results of Welch's t-test showed a significant difference in the total score of P-UCAPI among three groups ($F_{(2,36.892)}$=23.404, p<0.001). Games-Howell post hoc test results showed that this difference was not significant between groups A and B (p=0.333), but it was significant between groups A and C (p<0.001) and between groups B and C (p<0.001). The total score was higher in group C.

For the subscale of "listening and concentrating", Welch's t-test results showed a significant difference among three groups ($F_{(2,35.656)}$=11.152, p<0.001). Games-Howell post hoc test results showed that the difference

Table 3. Descriptive statistics of scores in each subscale of the Persian-university of Cincinnati auditory processing inventory for three age groups (A, B, and C)

UCAPI subscales	Group	Mean	SD	Min	Max	Mode
Total P-UCAPI Score	A	52.10	8.56	35	66	46
	B	55.35	5.35	39	62	54
	C	65.75	5.96	57	78	64
Listening and concentrating	A	13.55	3.02	8	18	15
	B	14.45	2.35	10	20	16
	C	19.55	4.89	13	28	17
Understanding speech	A	5.20	1.24	3	7	6
	B	5.40	0.82	4	7	5
	C	7.40	1.05	6	9	8
Following spoken instructions	A	7.05	2.01	3	11	8
	B	7.40	1.85	4	10	8
	C	7.65	1.46	5	10	8
Attention	A	7.30	1.08	6	10	7
	B	8.00	1.62	6	12	7
	C	9.00	2.13	6	14	8
Educational assistance	A	6.40	2.35	5	13	5
	B	6.20	2.28	5	13	5
	C	5.40	1.23	5	9	5
Other	A	12.60	2.62	9	17	12
	B	13.90	1.94	10	18	14
	C	16.75	1.97	13	21	17

was not significant between groups A and B (p=0.549). However, the difference was significant between groups A and C (p<0.001) and between groups B and C (p=0.001).

The result of one-way ANOVA for the subscale of "Understanding speech" showed a significant difference among groups ($F_{(2,57)}$=26.866, p<0.001). Turkey's post hoc test results showed that the difference was not significant between groups A and B (p=0.819). However, the difference was significant between groups A and C (p<0.001) and between groups B and C (p<0.001).

The mean score of "Following spoken instructions" was not significantly different among three groups ($F_{(2,57)}$=0.568, p=0.570). The mean score of "Educational assistance" subscale was 6.40, 6.20, and 5.40 in groups A, B, and C, respectively.

Regarding the subscale of "attention", Welch's test results showed a significant difference among three groups ($F_{(2,35.278)}$=5.260, p=0.010). This difference was not significant between groups A and B (p=0.257), and between groups B and C (p=0.230). However, the difference between groups A and C was significant (p=0.010).

One-way ANOVA results for the subscale of "other"

showed a significant difference among three groups ($F_{(2,57)}$=218.587, p<0.001). Turkey's post hoc test results showed that the difference was not significant between groups A and B (p=0.158). However, the difference was significant between groups A and C (p<0.001) and between groups B and C (p<0.001).

Discussion

The various areas of the brain work together to interpret sensory information [9]. Parts of the brain are dedicated to integrating and processing of auditory information. The speech perception is done in a number of acoustic and linguistic conditions such as in quiet environment, under degraded conditions, or in noisy environment [9]. The UCAPI is a comprehensive auditory processing questionnaire with six subscales, each of which measures a different aspect of auditory processing. In this pilot study, we aimed to provide a background for evaluating the normative data of this test for narrower age groups in Iran. In this regard, three groups of subjects with different ages were selected from among normal-hearing people to investigate the effects of aging on the auditory processing abilities.

Our findings showed that the P-UCAPI scores were significantly different among three groups, indicating that the auditory processing abilities is affected by aging. In most of the domains such as listening and concentrating, understanding speech, attention, other, as well as the total score, there were significant differences between the oldest group and the two other younger groups, such that the increase of age resulted in poorer scores.

Speech perception difficulties are because of reduced acoustic redundancies in the signal resulted from environmental noise, music, or competing speech. Those distractors reduce the signal-to-noise ratio making speech understanding difficult. In addition, the reduced cochlear, nerve, and central auditory pathways resulted from aging reduces the redundancies of the signal, causing increased problems with speech understanding as people get old [10]. Degraded speech also increases the challenges of cognitive functions such as auditory attention. The mental skills such concentration and attention are essential for listening, in addition to the acoustic characteristics of the signal (e.g., background noise, speech intensity, sentence length, complexity of the message) [11]. Hence, the ability to understand speech involve some parts of brain which is declined with aging [9]. Results of this study confirmed that with the increase of age, the speech perception ability is declined. The same result was reported in a study on age-related changes in the neural mechanics of dynamic auditory attention conducted by Herrmann et al. [12].

Chinnaraj et al. [13] studied auditory processing skills of normal-hearing younger (18–25 years) and older (50–70 years) adults and hearing-impaired older adults (50–70 years). Participants were evaluated using some auditory processing tests such as dichotic consonant-vowel test, gap detection test, speech-in-noise test, working memory tests (forward and backward span), and duration pattern test. Their results also showed a significant decline in auditory abilities with the increase of age. Stothart and Kazanina [14] studied the effect of neurologically aging on hearing abilities. They concluded that the inhibitory deficits are consistent pattern in older adults, shown by some electrophysiological tests using waves that were delayed or had amplitude reduction, and in some cases were absent.

The educational assistance item was the only item that was lower in the older group. This finding is logical due to the quality of education in the past years. Older adults had fewer educational opportunities when were young and there was less knowledge of auditory and learning disabilities. In our study, although no significant differences in total score and the subscale scores of the P-UCAPI between groups A and B was reported, the group B had higher scores compared to group A. Moreover, no significant difference was found in the score of attention subscale between groups C and B and between groups A and B, but there was a significant difference between groups A and C, indicating a gradual decrease in scores with aging. These findings, in overall, confirm the need for separate norms of P-UCAPI for narrower age groups in Iran. Further studies with a larger sample size are recommended to find separate norms for each age group.

Conclusion

The increase of age leads to poorer scores in most subscales of the Persian version of the University of Cincinnati Auditory Processing Inventory (P-UCAPI), listening and concentrating, understanding speech,

attention, other, and its total score. Since the P-UCAPI is a cost-effective, simple yet comprehensive tool for assessing Auditory Processing Disorder s, having norms for narrower age groups can be beneficial for more accurate screening of these problems in the clinic.

Ethical Considerations

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Authors' contributions

VKS: Study design, statistical analysis, interpretation of the results, and writing the manuscript; EK: Study design, acquisition of data, and writing the manuscript; RWK: Writing the manuscript; critical editing; GM: Study design, supervising the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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